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PATENT

School of Chemical Engineering
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G Akay
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Galip AKAY et al.

Serial No. 09/856,182 Group Art Unit: 1651

Filed: September 5, 2001 Examiner: David M. Naff

For: MICROCELLULAR POLYMERS AS CELL GROWTH MEDIA AND NOVEL POLYMERS

DECLARATION UNDER 37 CFR 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office Action mailed July 27, 2004, please enter the above-identified declaration as found below.

1) I, Galip Akay declare that I am the inventor of the above named patent application. My credentials in this field are explained in my curriculum vitae that is attached to the declaration.

2) I, Galip Akay am familiar with the above named patent application.

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3) I understand that the above patent application is pending before the US Patent and Trademark Office and that rejections to Claims 62 to 127 remain outstanding.

4) The inventions are summarised in Sections 1.1 – 1.5 indicating the text and examples. I believe that the descriptions are sufficient for a skilled person to perform the experiments. I need to emphasise that the patent application is multi-disciplinary as indeed reflected by the background expertise of the inventors.

5) Basic Pores: For very small Basic pores in 0.5 – 5 μm range predominantly extensional flows at low temperatures are to be used (page 20). For very large Basic pores in the range 50 – 300 μm high emulsification temperature (above 60 C) is used and deformation rate which is just above the critical deformation rate below which the emulsion becomes unstable. (pages 20 – 23, 27,-29 example –A1). Because large size Basic pores are more important in tissue engineering, the example was given on this type of pore structure.

6) Coalescence Pores: Description of the method is in pages 10, 20 – 21, the examples are provided in Examples A2 and A6.

7) Micro-capillaries: The preparation, use and significance of this type of pores are described in pages 10, 11, 15-18 and example C.

8) Nano-pores: The preparation and its significance in tissue engineering and biotechnology are described in pages 10, 11 and 20 and example A6.

9) The present invention can be summarized into four basic steps:

a) Select emulsion composition (basic composition, optionally includes water soluble polymers in aqueous phase or hydrophobic oils in oil phase (coalescence), optionally include oil phase fillers (nano-pores); and create the emulsion (vary dosing and a mixing rate, time, etc according to example A);

b) Homogenize (manipulates emulsion properties);

c) Lay up components (single phase or first, co-extrude, and optionally include fibres for micro-capillary formation); and

d) Polymerize using heat and/or pressure (optionally extracting fibers to make microcapillary formation).

10) The technical difference between Basic and Coalescence pores lies in the emulsion composition. By including water soluble polymers in the aqueous phase or hydrophobic oils in the oil phase of the emulsion, conducting Basic pore type emulsion formation and polymerizing as with the Basic pore type procedure, the added components in the emulsion coalesce the dispersed phase droplets in the emulsion during the polymerization stage, i.e. they cause the dispersed droplets to recombine, thereby creating very large droplets of non-polymerizable material about which the monomers present in the emulsion polymerize.

11) The oil and aqueous phases should not contain any additional material, which can change the solubility of the monomer or cause emulsion breakdown. However, if small quantities of additional material used, the primary pores are still obtained. The 'smallness' of the amount is dependent on the molecular weight of the water-soluble polymer or the hydrophilicity of the oil (co-monomer) used in the oil phase. The specification examples clearly illustrate these changes. Mixing conditions are used to determine the desired pore size. The creation of primary pores with controlled size (Example A) essentially requires the evaluation of emulsion stability diagram in terms of dosing time and mixing. This was present in the thesis by (Vikki Price, now Vikki Byron, PhD Thesis, Newcastle University, 2000 (not accessible until 2005).

12) If coalescence or nano-pores are desired, use oil phase and/or aqueous phase additives as exemplified in the specification. Since coalescence takes place during polymerization, controlling the size of the emulsion droplets can control the degree of coalescence. If the droplets are small, the size of the coalescence pores will be small. Therefore the size of the coalescence pores can be controlled by controlling the emulsion droplet size as described earlier.

13) The creation of a 3D network of continuous capillaries is achieved by using a special mold with a network of continuous fibers arranged in a desired architecture. The emulsion is then pumped into the mold and the emulsion is allowed to polymerize. The size of the pores is again dictated by the size of the emulsion droplets and the capillary pores are dictated by the fiber diameters. In order to create an emulsion with a uniform size distribution, use of the homogenization stage is desirable where the emulsion after the dosing period is mixed further prior to polymerization.

14) I have created a schematic diagram based on the examples in the specification, which I believe will assist the Examiner in understanding the scope of the invention as Appendix A.

15) The technique of the production of polymer with controlled pore and interconnect size with in-situ surface modification and with micro-architecture and the use of these polymers in tissue engineering where pore size dependent cell response has been discovered and are novel. These discoveries are illustrated by examples in both processing and through the tissue engineering applications. Since making this patent application, the work carried out along the teaching of the patent, we have confirmed and published scientific papers and doctorate two theses on the subject.

These publications include:

1. V.J. Price, PhD Thesis, Newcastle University, 2000 (not accessible until 2005).

2. MA Bokhari, PhD Thesis, Newcastle University, 2003.

3. MA Bokhari, MA Birch and G Akay, Advances in Experimental Medicine and Biology, Vol. 534, pp. 247-254, 2003.

4. G. Akay, MA Birch and MA Bokhari, Biomaterials. 2004 Aug; 25(18):3991-4000.

5. E. Erhan, E. Yer, G. Akay, B. Keskinler, D. Keskinler, J. Chemical Technology and Biotechnology, 79 (2004) 195-206.

6. G. Akay, E. Erhan, and B. Keskinler, Bioprocess intensification in flow through monolithic micro-bioreactors with immobilized cells, 'Biotechnology and Bioengineering, In press (2005).

7. MA Bokhari, G. Akay, and MA Birch, Biomacromolecules, Submitted for publication, 2004.

8. MA Bokhari, G. Akay and S. Zhang, and MA Birch, Biomaterials, submitted (2004).

9. G. Akay, et al, J. Membrane Sci., Vol. 206, pp. 63-68 (2002).

10. O.N. Umez-Eronini, et al., In vivo xenograft model using PolyHIPE as 3D scaffold in tissue engineering of urological tissue, J. Urology. Submitted (2004).

11. G. Akay, MA Bokhari, VJ Byron and M. Dogru, 'Development of nano-structured micro-porous materials and their application in bioprocess-chemical process intensification and tissue engineering', In: New Trends and Developments in Chemical Engineering, Wiley, 2005. In press.

In addition, independent work was carried out at Durham University using these materials in tissue engineering by Dr N Cameron acknowledging the patent in question.

16) The undersigned declares further that all statements made herein of his own knowledge are true and all statements made upon information and belief are believed to be true; and further that these statements are made with the knowledge that wilful, false statements and the like are punishable by fee, imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the above-identified pate application or patent issuing thereon.

Dated: 28/10/2004 Galip Akay: Galip Akay

CV – Prof G Akay

Summary of Recent Achievements

(List of publications and achievements given below date back to 2001 which is the starting date of the next Research Assessment Exercise which is held every 6 years in the UK to rank the research at the UK universities. In the last assessment held in 2001, Chemical Engineering Department of Newcastle University received grade 5, alongside Cambridge and UMIST in England. Top grade is 5*):

1. Organiser of the 1st International Symposium on Process Intensification and Miniaturisation (in Biological, Chemical, Environmental and Energy Conversion Processes), Newcastle University, 2003.
2. Regional Editor of International Journal of Transport Phenomena.
3. Editorial board member of Journal of Green Energy.
4. Founder and current 'director of research' of Newcastle University spin out company, Intensified Technologies Incorporated (ITI) which secured £7 million funding, dedicated to the exploitation of Intensified Processes in biological, chemical, environmental and energy conversion processes. ITI is based on 12 patents / patent applications generated by my research group. Estimated royalty payment to the University of Newcastle is £2M /year within 5 years.
5. Completed an EPSRC funded project on 'Intensive agglomeration and micro-encapsulation of powders' (£198K from EPSRC and £40K cash from industry)
6. Started a LINK project on 'Intensified integrated oil/water – gas/liquid separations and produced water treatment' with 8 companies funded through the 'Sustainable Technologies Initiative'. (£297K from EPSRC and £100K cash + £200K in kind from industry).
7. Additional funding from industry and local authority on the intensification of biogas clean-up using micro-porous polymers and power generation using internal combustion engine (£135K).
8. Funding from EXXON (USA) (£72k, in 2004).
9. Published/accepted over 30 journal papers.
10. Published 24 conference publications /presentations.
11. Published / applied for 12 patents / patent publications.
12. Made 10 plenary/keynote presentations in international conferences.
13. Organisation/scientific committee membership of 8 international conferences.
14. Supervised successfully 4 PhD and 1 MPhil.
15. A book on 'Process Intensification and Miniaturization in Biological, Chemical, Environmental and Energy Conversion Processes' will be published by Elsevier in 2005.
16. **My research group (Process Intensification and Miniaturisation PIM) designed, supervised the construction and recently commissioned a 1 MWe power plant based on biomass waste, including municipal solid waste and sewage sludge and other industrial waste. The plant contains process water cleanup, gas conditioning and emissions monitoring technologies based on PIM's research. Similar plants in the region will be built commercially.**

Summary of Research Experience

I have interdisciplinary training and research experience which include: Chemical Engineering; Mathematics; Chemistry; Materials, Surface, Interface, Environmental and Energy Sciences; and more recently, Catalysis; Biology; Biotechnology; and Tissue Engineering. Since 1980, I have been developing the highly interdisciplinary discipline of 'Phenomenon Based Process Intensification' (PBPI) which is now being taken up by academics and industry. PBPI is an

important element of sustainable technology. I discovered the phenomenon of Flow Induced Phase Inversion (FIPI) and applied it to the intensive processing of structured liquids (detergents/surfactants), emulsions (including food emulsions such as margarine and low fat spreads), dispersions, structured particles, high internal phase emulsions (HIPEs) and HIPE polymerised polymers which are micro-porous, and known as PolyHIPE Polymers. Based on FIPI, I have received more than 30 patents for Unilever.

In academia my research group discovered 'non-isothermal FIPI' and several 'size dependent phenomena' applied to the deposition from solution of surfactants and chemicals, the behaviour of bacteria and animal cells within well defined microscopic pores, produced through FIPI emulsification and polymerisation. These discoveries resulted in 12 patents/ patent applications in the intensification of: crude oil-water separation, gas-liquid separation, preparation of nano-structured micro-porous polymers and metals, micro-reactors used in bioprocess intensification, tissue engineering and xenografts, intensified catalysis, intensification equipment, and agricultural delivery systems / soil conditioners. I collaborate extensively with academics and industry.

Potentially, the ability to prepare a well controlled micro-reaction environment with or without superimposed nano-structure and with a prescribed surface or bulk chemistry in order to examine the behaviour of micro-organisms and macro/super molecular systems presents new frontiers in basic science and biology as well as in chemical engineering and related disciplines.

PUBLICATIONS SINCE 2001

I have more than 200 cited publications in diverse fields including: Chemical engineering, radiation and polymer chemistry, mathematics/numerical methods, polymer science and engineering, fluid mechanics, rheology, materials science, colloid/interface science, membrane processes, surfactants, biotechnology and medicine. Below I give my publications since 2001 which is the starting year for the next Research Assessment Exercise in UK. These publications are intended to reflect my current and future interests.

A - JOURNAL PUBLICATIONS SINCE 2001

1. G. Akay, and L. Tong, Preparation of low density polyethylene latexes by flow induced phase inversion emulsification of polymer melt in water, **J. Colloid and Interface Sci., 239 (2001) 342-357.**

2. G. Akay, L. Tong, M.J. Hounslow, and A. Burbidge, Intensive agglomeration and microencapsulation of powders, **Colloid and Polymer Sci., 279 (2001) 1118-1125.**

3. Y.K. Bayhan, B. Keskinler, A. Cakici and G. Akay, Removal of divalent heavy metal mixtures from water by saccharomyces cerevisiae using crossflow microfiltration, **Water Research, 35 (2001) 2191-2200.**

4. E. Erhan, B. Keskinler, G. Akay and O.F. Algur, Removal of phenol from wastewater by using membrane immobilized enzymes: Part 1. Dead end filtration. **J. Membrane Sci., 206 (2002) 361-373.**

5. G. Akay, E. Erhan, B. Keskinler, and O.F. Algur, Removal of phenol from wastewater by using membrane-immobilized enzymes: Part 2. Crossflow filtration. **J. Membrane Sci., 206 (2002) 61-68 (In the list of most downloaded articles)**

6. B. Keskinler, G. Akay, Y.K. Bayhan and E. Erhan, The effect of ionic environment on the crossflow microfiltration behaviour of yeast cell suspensions, **J. Membrane Sci., 206 (2002) 351-360.**

7. A. Midilli, M. Dogru, G. Akay and C. Howarth, Hydrogen production from sewage sludge via a fixed bed gasifier product gas, **Int. J. Hydrogen Energy, 27 (2002) 1035-1041.**

8. M. Dogru, C.R.Howart, G. Akay, B. Keskinler and A.A. Malik, Gasification of Hazelnut shell in downdraft gasifier, **Energy 27 (2002) 415-427.**

9. A.Nuhoglu, T. Pekdemir, E. Yildiz, B. Keskinler, and G. Akay, Drinking water denitrification by a membrane bio-reactor, **Water Research, 36 (2002) 1155-1166.**

10. E.Erkoc, S. Yapici, B. Keskinler, A. Cakici and G. Akay, Effect of pulsed flow on the performance of carbon felt electrode, **Chem. Eng. Journal, 85 (2002) 153-160.**

11. G. Akay, L.Tong and R Addleman, Process intensification in particle technology: Intensive granulation of powders by thermo-mechanically induced melt fracture, **Industrial & Engineering Chemistry Research , 41 (2002) 5436-5446.**

12. G. Akay, L.Tong, H. Bakr, R.A. Choudhery, K. Murray and J. Watkins, Preparation of ethylene vinyl acetate copolymer latex by flow induced phase inversion emulsification, **J. Materials Sci., 37 (2002) 4811-4818.**

13. L. Tong and G. Akay, Process intensification in particle technology,: Flow induced phase inversion in the intensive emulsification of polymer melts in water, **J. Materials Sci., 37 (2002) 4985-4992.**

14. G. Akay, and L. Tong, (2003) Process intensification in polymer particle technology: Granulation mechanism and granule characteristics, **J. Materials Sci., 38, (2003) 3169- 3181.**

15. T. Pekdemir, G. Akay, M. Dogru, R.E. Merrells, and B. Schleicher, Demulsification of highly stable water-in-oil emulsions, **Separation Science and Technology, 38 (2003) 1161-1184.**

16. B.Keskinler, E.Erhan, G.Akay, M.Kaya and B.Bayguven., Microfiltration of whey proteins adsorbed on yeast cells, **Int. J. Food Sci. Tech., 38 (2003) 1-8.**

17. E.Yildiz, A.Nuhoglu, B.Keskinler, G.Akay, B.Farizoglu, Water softening in a crossflow membrane reactor, **Desalination, 159 (2003) 139-152**

18. T.Pekdemir, B.Keskinler, E.Yildiz and G.Akay, Process intensification in wastewater treatment: ferrous iron removal by a sustainable membrane bioreactor system, **J. Chem. Technology and Biotechnology, 78 (2003) 773-780.**

19. G. Akay and L. Tong, Process intensification in particle technology: Intensive agglomeration and microencapsulation of powders by non-isothermal flow induced phase inversion process, **International Journal of Transport Phenomena, 5 (2003) 227-245.**

20. M. Bokhari, M. Birch and G. Akay, Polyhipe polymer: A novel scaffold for in vitro bone tissue engineering, **Advances in Experimental Medicine and Biology, 534 (2003) 247 – 254.**

21. E. Erhan, E. Yer, G. Akay, B. Keskinler, and D. Keskinler, Phenol degradation in a fixed-bed bioreactor using micro-cellular polymer immobilized *Pseudononas syringae*, **J. Chem. Technology and Biotechnology, 79 (2004) 195-206.**

22. M. Dogru, A. Midilli, G. Akay, and C.R. Howarth, Gasification of leather residues – Part 1: Experimental study via a pilot-scale air-blown downdraft gasifier, **Energy Sources, 26 (2004) 35-44.**

23. A. Midilli, M. Dogru, G. Akay, and C.R. Howarth, Gasification of leather residues – Part 2: Conversion into combustible gases and the effects of some operational parameters, **Energy Sources, 26 (2004) 45-53.**

24. G. Akay, Upping the ante in the process stakes, **The Chemical Engineer, February 752 (2004) 37-39.**

25. G. Akay, M.A. Birch, M. A. Bokhari, Microcellular Polyhipe polymer (PHP) supports osteoblastic growth and bone formation in vitro, **Biomaterials, 25 (2004) 3991-4000.**

26. B. Keskinler, G Akay, T. Pekdemir, E. Yildiz and A. Nuhoglu, Process intensification in wastewater treatment: Oxygen transfer characterization of a jet loop reactor for aerobic biological wastewater treatment, **Int. Journal Environmental Technology and Management, 2004 (in press).**

27. B. Keskinler, E. Yildiz, E. Erhan, M. Dogru, and G. Akay, Crossflow microfiltration of low concentration- non-living yeast suspensions, **J. Membrane Sci., 233 (2004) 59-69.**

28. B. Keskinler, E. Erhan, G. Akay, M. Kaya and B. Bayguven, Microfiltration of whey proteins adsorbed on yeast cells, **Int. J. Food Sci. Technol., 39 (2004) 71-78.**

29. E. Yildiz, B. Keskinler, T. Pekdemir, G. Akay, and A. Nuhoglu, High strength wastewater treatment in a jetloop membrane bioreactor: Kinetic and performance evaluation, **Chemical Engineering Science, (2004). In press.**

30. G. Akay, E. Erhan, B Keskinler, Bioprocess intensification in flow through micro-reactors with immobilized bacteria, **Bioengineering Biotechnology, (2004). In press.**

31. MA Bokhari, G Akay, S and MA Birch, The use of microcellular PolyHIPE Polymer in tissue engineering as *in* vitro scaffolds for osteoblastic cell growth, **Biomacromolecules,** Accepted, subject to correction.

32. ON Umez-Eronini, DE Neal, J. Southgate, G.Akay, M.Bokhari, R. Pickard, A. Collins, *In vivo* xenograft model using hydroxyapatite coated micro-cellular Polyhipe Polymer as a three-dimensional scaffold in the tissue engineering of urological tissue, **Journal of Urology, Submitted (2004).**

33. M.A. Bokhari, G. Akay, S Zhang and MA Birch, A hybrid biomaterial combining the peptide hydrogel RAD 16-1 with PolyHIPE Polymer (PHP) enhances osteoblast growth and differentiation *in vitro.* **Biomaterials, (2004) accepted.**

34. G. Akay, M. Dogru, B. Calkan and O.F. Calkan, Flow induced phase inversion phenomenon in process intensification and micro-reactor technology. In: **Microreaction Technology and Process Intensification,** Eds: Y Wang and J Halladay, **American Chemical Society Symposium Series. Submitted (2004)**

35. G. Akay, Z.Z. Noor, M. Dogru and S.R. Larter, Process intensification in water-in-crude oil emulsion separation by simultaneous application of electric field and novel demulsifier adsorbers based on Polyhipe Polymers. In: **Microreaction Technology and Process Intensification,** Eds: Y Wang and J Halladay, **American Chemical Society Symposium Series. Submitted (2004).**

36. G. Akay, Bioprocess and chemical process intensification. In: **Encyclopedia of Chemical Processing**, Ed: S Lee, Marcel Dekker, NY. **Submitted (2004).**

B - JOURNAL PUBLICATIONS IN PREPARATION

The following papers or set of papers are in preparation for submission. They are mainly based on confidential theses or reports where the confidentiality will expire soon.

1. OS Yildirim, G Akay, MA Bokhari and A MacCaskie, Preliminary experimental results on the biocompatibility of a novel composite bone graft consisting of hydroxyapatite and polyHIPE polymer in rabbits, **Tissue Engineering** (Collaborative work with a hospital, 1st draft is available)

2. G. Akay, VJ Byron and S. Downes, Novel composite micro-porous polymers for animal cell growth, Parts 1,2. **Tissue Engineering** (Based on Dr Byron's PhD thesis (2001) which will remain confidential until January 2005. This was a collaborative work with Prof Sandra Downes of Nottingham University, Department of Human Anatomy).

3. G. Akay, Intensification of separation processes, **The Chemical Engineer** (invited review, to be published in a special issue of the journal.

4. G Akay, O Calkan, M. Dogru, AC Jordan, Gasification of sugar cane bagasse using 10KWe intensified down-draft gasifier and gas quality assessment, **J. Green Energy** (Based on MSc thesis of AC Jordan and part PhD work of O Calkan, and post-doc work of Dr Dogru, funded by the LINK Project)

5. G Akay, ZZ Noor, M Dogru and SR Larter, Intensification of water-in-crude oil emulsion separation using polymeric micro-cellular demulsifiers in the presence of electric field, **Separation Science and Technology** (Based on the on going PhD work of ZZ Noor and post-doc work of Dr Dogru, funded by the LINK Project)

6. G. Akay, B Calkan, M Dogru, Nano-structured micro-porous catalysts: Part -1. Preparation, **J. Catalysis,** Part -1: Preparation; Part – 2: Mechanism of structure formation, (Based on the on going PhD work of B Calkan and post-doc work of Dr Dogru, funded by the LINK Project)

7. G. Akay, MA Bokhari, VJ Byron, and S Downes, Preparation of microcellular polymers with controlled internal architecture, **Polymers for Advanced Technologies** (Based on the PhD theses of Dr Bokhari (2004) and Dr Byron (2001)).

8. G. Akay, T. Pekdemir and J. Vickers, Formation and intensified demulsification of highly stable emulsions during nuclear re-processing. Parts 1-5. **Separation Science and Technology**, Based on the PhD Thesis and 2- year post-doctoral works by Drs Pekdemir and Vickers supported by BNFL (1997-2002) under a confidentiality agreement. Reports available (1200pp) which was in part patented [G. Akay and J.

Vickers, Method for separating oil in water emulsions, EP13074202A2 (2003)].

9. G. Akay, M Dogru, A. Kazeem, and ZZ Noor, Flow induced phase inversion in the intensive processing of nano-sized emulsions: Proton relaxation NMR study, **AICE Journal** (Based on Ms Noor's on going PhD work and Dr Dogru's post-doc work, supported by the LINK project).

10. PT Odirile and G Akay, Process Intensification in surfactant mediated separation processes: Metal ion removal from water using surfactants in the presence of electric field, **Separation Science and Technology** [based on Dr Odirile's PhD thesis (2001) which is due for release in October 2004. Thesis was partly published (1999, 2000) and patented (2004)].

C– PATENTS, PATENT PUBLICATIONS AND APPLICATIONS

1. G. Akay, Stable oil in water emulsions, EP 649 867 (2001).

2. G. Akay, GN Irving, AJ Kowalski, D. Machin, Process for the production of liquid compositions, European Patent, EP 799303 (2001)

3. G Akay, Stabile oel – in – wasser emulsionen und verfahren zu deren herstellung, DE69330954C (2001).

4. G. Akay et al, Verfahren zur herstellung von fluessigen zusammensetzunggen, DE69523623T2, (2002).

5. G. Akay and N. Irving, Dynamic mixing apparatus for the production of liquid compositions, US 63445907 (2002).

6. G. Akay et al., Procedimiento para la produccion de composicion liquida, ES 2166839T3, (2002)

7. G. Akay, S. Dawnes, VJ Price, Microcellular polymers as cell growth media and novel polymers, EP 1183328 A2 (2002); US 09, 856,182 (2002).

8. G. Akay and J. Vickers, Method for separating oil in water emulsions, EP13074202A2 (2003).

9. M. Dogru and G Akay, Intensified and Miniaturized Gasifier with Multiple Air Injection and Catalytic Bed, British Patent Application, GB 0325668.2 (2003).

D- EDITED BOOK

G. Akay and M. Dogru (Eds): Process Intensification and Miniaturization in Biological, Chemical, Environmental and Energy Conversion Technologies, Docqwise, York, 2003. ISBN # 0-9545956-0-2.

E- CONFERENCE PUBLICATIONS AND PRESENTATIONS

Refereed Publications:

1. G. Akay, Flow induced phase inversion: Mechanism and applications, in 'Recent Advances in Transport Phenomena' Eds: I Dincer and M.F. Yardim, pp. 11-17, Elsevier, Paris, 2001. (12th International Symposium on Transport Phenomena, July 2001, Istanbul, Turkey) **Keynote paper.**

2. G. Akay, M. Dogru, T. Pekdemir, and J. Vickers, Process intensification in oil water separation: Development of a demulsifier and its performance in emulsions produced in nuclear reprocessing plants and crude oil recovery, Progress in Transport Phenomena, Eds: S. Dost, H. Struchtrup and I. Dincer, pp. 3-10 , Elsevier, Paris, 2002. (13th International Symposium on Transport Phenomena, 14-18 July 2002, University of Victoria, Victoria, Canada). **Keynote paper.**

3. G. Akay and L. Tong, Process intensification in particle technology: Intensive agglomeration and microencapsulation of powders by thermomechanically induced melt fracture. Progress in Transport Phenomena, Eds: S. Dost, H. Struchtrup and I. Dincer, pp. 681-688 , Elsevier, Paris, 2002. (13th International Symposium on Transport Phenomena, 14-18 July 2002, University of Victoria, Victoria, Canada).

4. M. Dogru, G. Akay, C.R. Howarth, B. Keskinler M.J. Ling, and A.A. Malik, Olive pips: A potential valuable biomass source of clean combastible gas using an intensive gasifier, Progress in Transport Phenomena, Eds: S. Dost, H. Struchtrup and I. Dincer, pp. 767-772 , Elsevier, Paris, 2002. (13th International Symposium on Transport Phenomena, 14-18 July 2002, University of Victoria, Victoria, Canada).

5. B. Keskinler, G. Akay, T. Pekdemir, E. Yildiz and A. Nuhoglu, Process intensification in wastewater treatment: Oxygen transfer characteristics of an aerobic jet loop reactor. Progress in Transport Phenomena, Eds: S. Dost, H. Struchtrup and I. Dincer, pp. 701-706 , Elsevier, Paris, 2002. (13th International Symposium on Transport Phenomena, 14-18 July 2002, University of Victoria, Victoria, Canada).

Non-refereed Publications:

6. Akay G., Dogru M., Howarth C.R. and Keskinler B., "*Bio-Energy Production from Leather Industry Waste by Gasification*", Proceedings of the **4th International Thermal Energy Congress**, Cesme, July 8-12, 2001, Turkey, 6 pp.

7. G. Akay and L. Tong, Process intensification in polymer powder technology, **IUPAC World Polymer Congress 2002**, Preprints, p.1033, July 7-12, Beijing, China (2002).

8. Liu, L., Hounslow, MJ, Akay, G., White, LT., A population balance understanding for a granulation process in a two-dimensional rotating Hele-Shaw granulator, **World Congress on Particle Technology**, Sydney, Australia, 2002, 8pp.

9. Bokhari, MA, Birch, MA, Akay, G., The use of micro-cellular Polyhipe polymers as in vitro scaffolds for osteoblastic cell growth, Proceedings of the **1st International Symposium on Process Intensification and Miniaturization**, Newcastle University, Newcastle upon Tyne, August 18-21, 2003, 7pp. ISBN # 0-9545956-0-2.

10. Akay G., Noor Z. Z., and Dogru M., "*Intensification Of Water-In-Crude Oil Emulsions By Simultaneous Application Of Electric Field And Novel Polymeric Demulsifiers*", Keynote Paper, Proceedings of the **1st International Symposium on Process Intensification and Miniaturization,** Newcastle University, August 18-21, 2003, 10 pp. ISBN # 0-9545956-0-2. **Keynote paper**.

11. Jordan A., Dogru M., Haile S.M. and Akay G., "*An Experimental Investigation into the Potential for Power Production from the Gasification of Sugar Cane Bagasse using a Throated Downdraft Gasifier*", Proceedings of the **1st International Symposium on Process Intensification and Miniaturization**, Newcastle University, Newcastle upon Tyne (UK) August 18-21, 2003, 6 pp. ISBN # 0-9545956-0-2.

12. Akram M, Dogru M and Akay G, "*Gasification of Municipal Solid Waste (MSW)-A Move towards A Sustainable World*", Proceedings of the **1st International Symposium on Process Intensification and Miniaturization**, Newcastle University, August 18-21, 2003, 5 pp. ISBN # 0-9545956-0-2.

13. Midilli A, Calkan O.F., Dogru M, Akay G and Howarth C.R., *"Clean Bio-Fuel Production From Sewage Sludge For Future Applications of Fuel Cells"*, Proceedings of the **1st International Symposium on Process Intensification and Miniaturization,** Newcastle, August 18-21, 2003, United Kingdom , 6 pp. ISBN # 0-9545956-0-2.
14. Akay G., Tong L., Dogru M. and Addleman R., "*Process Intensification, Process Miniaturization and Inherently Intensive Processes in Particle Technology*", Proceedings of the **1st International Symposium on Process Intensification and Miniaturization**, Newcastle, August 18-21, 2003, United Kingdom, 6 pp. ISBN # 0-9545956-0-2.

15. Dogru M, Akay G, Calkan O.F., Jordan C.A. and Calkan B, *"Gasification of Sugar Cane Bagasse for Power Production Using a throated Downdraft Gasifier"*, Proceedings of the **1st International Exergy, Energy and Environment Symposium,** Izmir, July 13-17, 2003, Turkey, 6 pp.

16. G. Akay, Flow induced phase inversion phenomenon in process intensification and micro-reactor technology, American Chemical Society 226th ACS Meeting, New York, NY, 7-11 September, 2003. Abstract. **Keynote address**.

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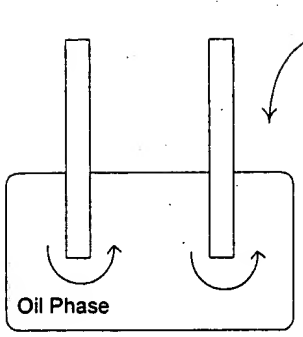
21. L.Liu, MJ Hounslow, G Akay, M van Sint Annaland, JMMM Kuipers, Coupling of population balances and computational fluid dynamics in dense phase systems, *AIChE Annual Meeting*, San Francisco, USA, November 203.

22. G. Akay, Integrated-intensified biomass based energy technology, **International Workshop on New and Renewable Energy,** Newcastle University, Newcastle upon Tyne, 18 – 21 August 2003. **Plenary presentation.**

23. G. Akay, Microporous catalyst support with nano-microstructure, **International Workshop on Nanotechnology,** Newcastle University, Newcastle upon Tyne, 18 – 21 August 2003. **Plenary presentation.**
24. G. Akay, Development of nano-structured micro-porous materials and their application in bioprocess and chemical process intensification, **New Trends in Chemical Engineering,** University of Salamanca, Salamanca, Spain, 21-25 February 2004. **Plenary presentation.**

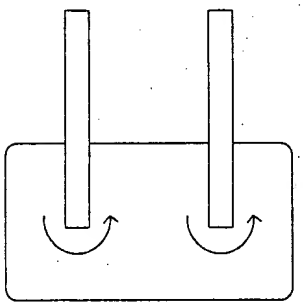
Appendix A

Stage 1
Emulsion
Formation



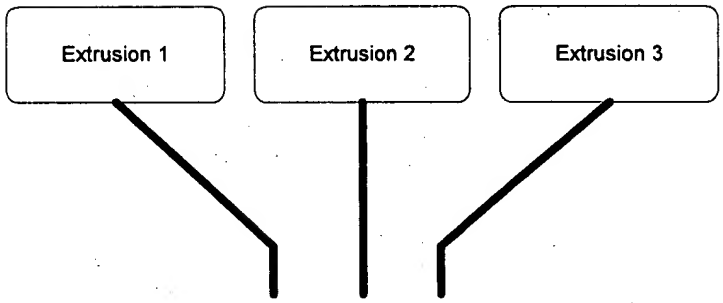
Basic Pores Form

Stage 2
Homogenization



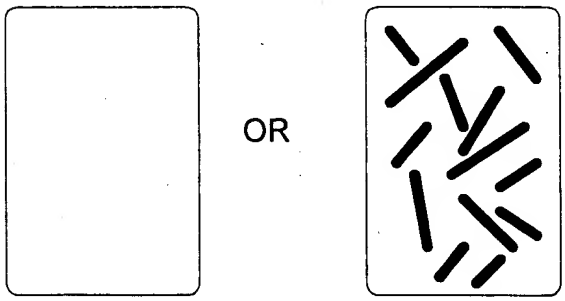
Variables of Mixing
Rats and Time

Stage 3
(Optional)
Co-Extrude



Single / Multiple Emulsions

Stage 3 (con't'd)
Mold Fill or
Lay up

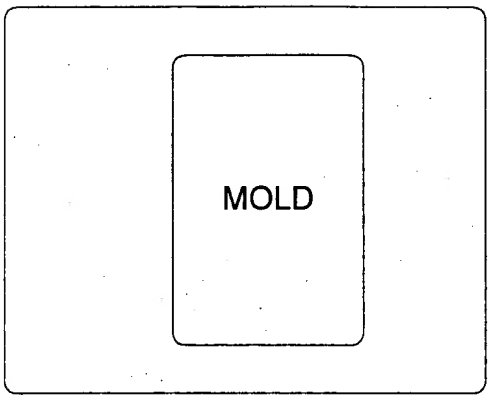


Solid Mold

Fiber Filled
Mold

Appendix A

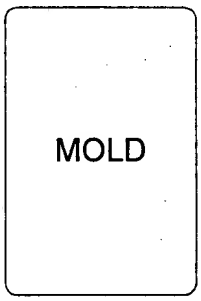
Stage 4
Polymerize



Coalescence Pores
Form

Autoclave: Heat, Pressure

Stage 5
Post - Polymerization



Extract Fillers with Solvent
Extract with Solvent & Heat

Nanopore Formation

Microcapillary Formation